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Polymorphism in pseudoscorpions: changes of trichobothrial pattern in *Roncus pannonius* Ćurčić, Dimitrijević, & Karamata (Neobisiidae, Pseudoscorpiones)

Božidar P.M. ĆURČIĆ, S.E. MAKAROV, and J.S. RADOVANOVIĆ
Institute of Zoology, Faculty of Science (Biology), University of Belgrade, Studentski Trg 16, 11000 Belgrade, Yugoslavia.

Polymorphism in pseudoscorpions: changes of trichobothrial pattern in *Roncus pannonius* Ćurčić, Dimitrijević, & Karamata (Neobisiidae, Pseudoscorpiones). - Polymorphism in trichobothrial pattern was studied in *Roncus pannonius*, inhabiting Yugoslavia. A total of 50 examples with changes of this pattern (or 1.43%) were found out of 3,486 specimens examined. Variations of trichobothriotaxy were affecting either both (2%) or a single chela (98%), and either the fixed (82%) or movable chelal finger (18%). Twenty-eight different types of changes were noted, including changes in the structure of pedipalpal podomeres and simultaneous reduction of some trichobothria; changes in the position of different trichobothria; reduction of their number; and duplications of some trichobothria. The most frequent changes were as follows: reduction of *isb* (16% of all trichobothrial aberrations); reduction of either *eb* or *esb* (14%); distal migration of *esb* (8%); and reduction of either *t* or *st* (6%). Other variants were less frequent (2–4% each). Trichobothrial variants in *R. pannonius* were confined mainly to males (54%) and females (40%), and less to tritonymphs (6%). Unilateral changes are predominantly dextral (69%), both on the fixed (68%) and movable chelal fingers (81%). Statistical analysis showed that only females exhibit a significant asymmetry in the changes of the trichobothrial pattern on the pedipalpal chelae. The probable causes for this type of this phenomenon were also discussed. Apart from some physical, mechanical, and chemical factors, it is assumed that both developmental and genetic factors spark the origin of changes in the trichobothrial pattern.

Key-words: Ontogeny - polymorphism - anomalies - trichobothriotaxy - pseudoscorpions - *Roncus pannonius*.

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INTRODUCTION

Each species of pseudoscorpion possesses a specific trichobothrial pattern. Species-specific distribution of the trichobothria produces a set of "normal" phenotypes. The absence, duplication, or migration of some of these organs give rise to changes in the normal trichobothrial pattern. If individuals with such deviations attain elevated frequencies within natural populations (for instance, if more than 1% of examples exhibited such phenotypes), this could be one manifestation of intraspecific polymorphism. Elevated frequencies of deviations from the "normal" trichobothrial pattern could be then ascribed to certain environmental events, or to significant changes in the population structure of the species (ĆURČIĆ et al. 1995; LUČIĆ 1995; MAKAROV 1995), such as a population bottleneck where inbreeding depression and genetic drift could be major factors in promoting such deviations.

Records of changes in the trichobothrial patterns in pseudoscorpions are rare and consist of brief reports by CHAMBERLIN (1949), ĆURČIĆ (1980, 1988, 1989), ĆURČIĆ & DIMITRIJEVIĆ (1990); DIMITRIJEVIĆ (1990); DROGLA (1988), and MAHNERT (1979, 1988).

Among the Chthoniinea, no changes in trichobothrial patterns have been found. In the Cheliferinea, a single (unilateral) abnormality was observed in the holotype (male) of *Xenochelifer davidi* Chamberlin from the USA (CHAMBERLIN 1949). The left movable (pedipalpal) chelal finger was greatly reduced and its trichobothrium *t* is missing (only *b* is present) as are the two pseudotactile setae (which normally occur submedially and subterminally on the finger). Furthermore, MAHNERT (1979) reported on an outstanding variation of trichobothrial pattern (or occasional reduction of these organs) in *Americhernes incertus* Mahnert, from Brazil (with *sb*, *st*, *b* or *sb* missing in some adults; *ist*, *sb* or *st* missing in tritonymphs; and *esb*, *ist*, and *b* missing in deutonymphs). Additionally, in the holotype (female) of *Ectromachernes mirabilis* Beier, from Ethiopia, the trichobothrium *et* is doubled (MAHNERT 1988).

Among the Neobisiinea, species have been found with deviations of trichobothriotaxy involving changes in the number, disposition, and presence/absence of trichobothria. Such deviations have been noted in *Neobisium bernardi* Vachon, from France (with right trichobothrium *t* missing; ĆURČIĆ & DIMITRIJEVIĆ 1989), *N. carcinoides* (Hermann), from Germany (*t* missing on right pedipalp; DROGLA 1988), *N. carpaticum* Beier, from Yugoslavia (with *ist*, *est*, *it*, and *et* missing on the left; ĆURČIĆ 1980), *N. cephalonicum* (Daday), from Yugoslavia (with symmetrical distal migration of *ist* on both pedipalpal chelae; ĆURČIĆ 1980), *Roncus jarilo* Ćurčić, from Yugoslavia (with anomalous position of *eb* or *esb* on the left; Ćurčić *et al.* 1992), and *R. pripegala* Ćurčić, from Croatia (with duplication of either *t* or *st* on the right; ĆURČIĆ 1988).

Qualitative and quantitative analyses of different samples of some neobisiid species revealed the presence of different changes affecting chelicerae, pedipalps, and walking legs (ĆURČIĆ *et al.* 1992, 1994; MAKAROV 1995); these phenomena were most frequent in the pedipalpal structures, less frequent in the walking legs, and rarest in the chelicerae. In the analysed species, different changes of the appendages were found: variation of size and shape of different podomeres; fusion and/or lack of different podomeres; changes in trichobothriotaxy; disturbed setal patterns; and variations in cheliceral and pedipalpal dentition (Ćurčić *et al.* 1995; Makarov 1995).

The primary aim of this study was to analyse the qualitative and quantitative variation of trichobothrial patterns in an endemic and relict pseudoscorpion species from Yugoslavia, and the probable factors affecting their development and distribution.

MATERIAL AND METHODS

We have analysed the variants of the trichobothrial patterns in a population of *Roncus pannonius* Ćurčić, Dimitrijević, & Karamata, from the village of Obrež, near Belgrade, Yugoslavia. A total of 3,486 specimens was examined, comprising 1,209 females; 1,600 males; 633 tritonymphs; 43 deutonymphs; and 1 protonymph.

Samples of this species were obtained by sifting oak and beech leaf litter and humus over a period from May 1993 to December 1993; samples were taken at least once a month.

After dissection, all specimens were mounted in Swan's fluid (gum chloral medium) and examined carefully. The terminology for trichobothrial aberrations in this study follows that given by Ćurčić *et al.* (1995). However, this terminology has been somewhat modified in the present paper to include the whole range of polymorphism in trichobothriotaxy of *R. pannonius* studied.

RESULTS

There was a total of 50 specimens (20 ♀♀, 27 ♂♂, 3 tritonymphs) with changed trichobothrial patterns, representing 1.43% of all individuals studied. In general, this percentage is much higher than the corresponding values which refer to the frequency of either abdominal or cheliceral or pedal anomalies in the same species (Ćurčić *et al.* 1991, 1994; Lučić 1995). Additionally, the analysis of the sample of *R. pannonius* showed that phenotypical variation of trichobothriotaxy was confined mostly to males (54%) and females (40%), and less to tritonymphs (6%) (Table 1, Figs 1–21).

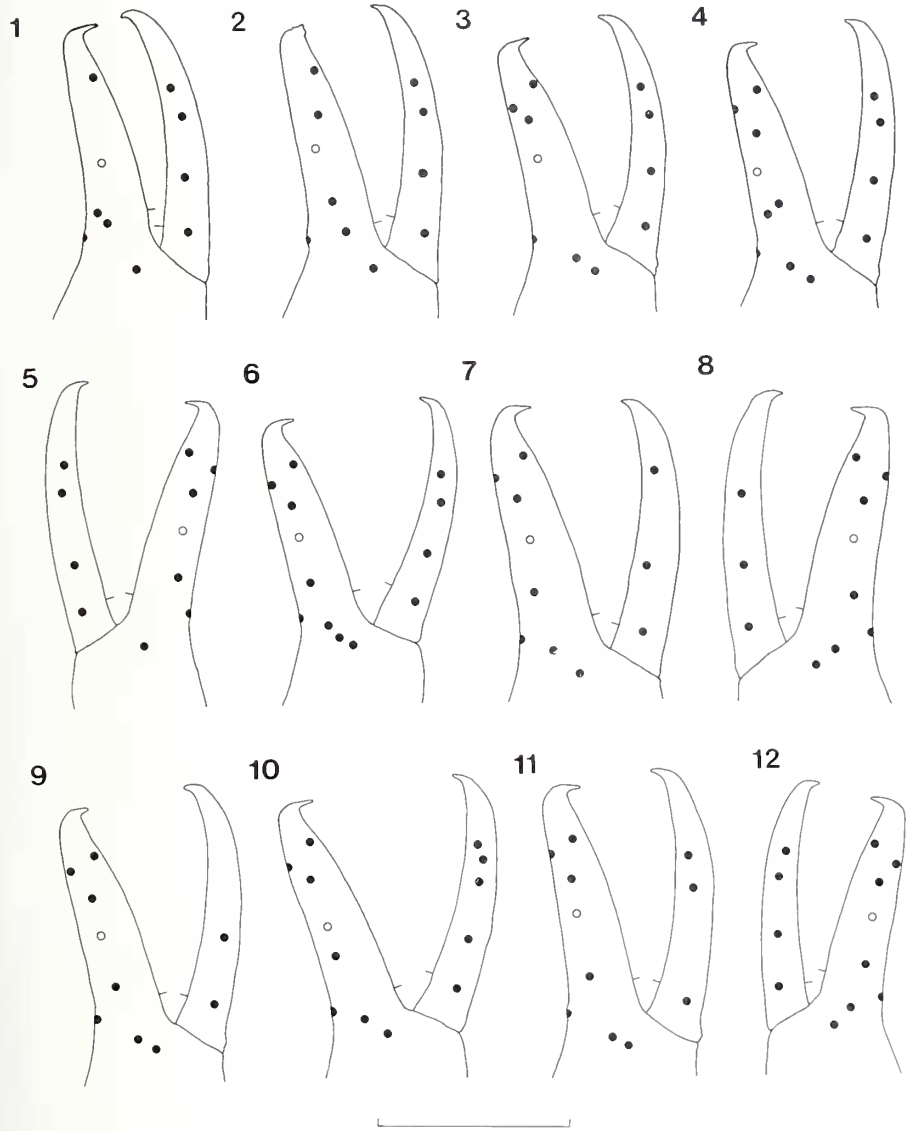
The deficiencies in trichobothriotaxy were variable. Thus, in the species analysed, as many as 28 different, single or combined, changes in trichobothrial pattern were noted (Table 1). Among these, changes affecting the number and disposition of trichobothria on the fixed (pedipalpal) chelal finger are more frequent than those on the movable chelal finger (82% vs. 18%).

The study of the frequency and relative distribution of trichobothrial changes in the adult and tritonymph stages of *R. pannonius* revealed the following: (1) variations in trichobothriotaxy are manifested by the simultaneous changes in the structure of two distalmost pedipalpal podomeres and in the number (i.e. reduction) of some trichobothria, by the changes in position of these setae, and the changes in their

TABLE 1

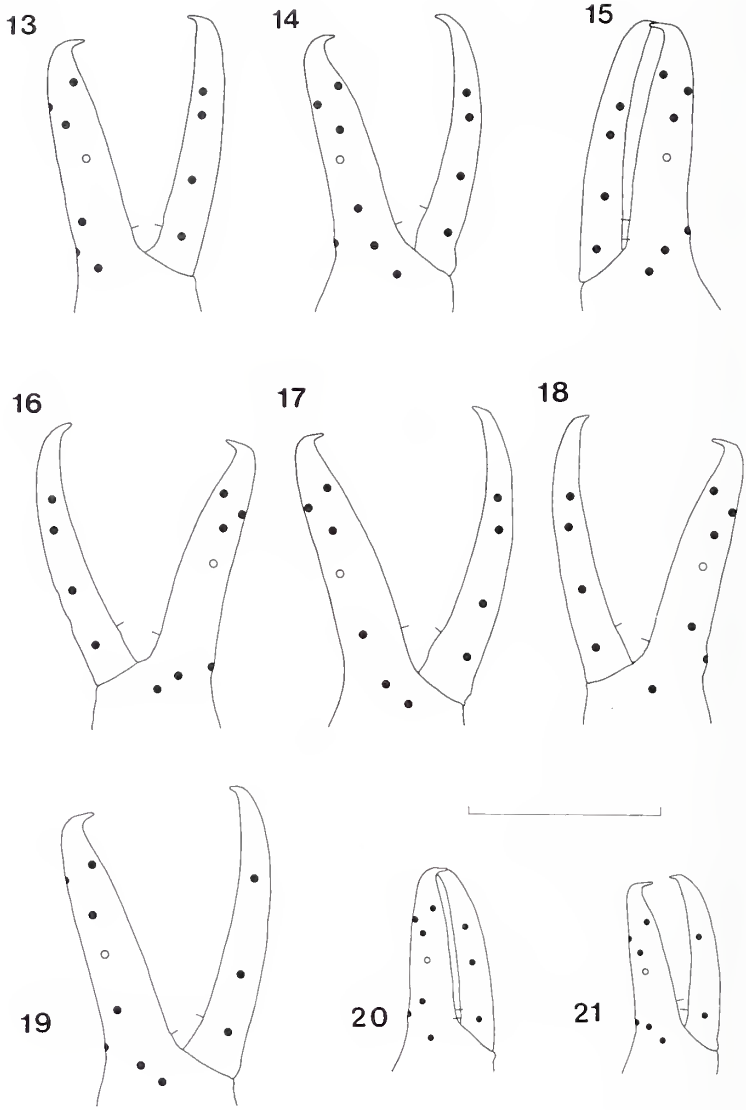
Frequency of different variants of trichobotriotaxy in *Roncus pannonius* (expressed as a percentage of the total number of these changes). Abbreviations: T = tritonymphs, %S = percentage of the relevant changes on the left, %D = percentage of the relevant changes on the right.

	♀♀	♂♂	T	Total	%S	%D
CHANGE ON BOTH CHELAE						
Reduction of (sinistral) *it* and reduction of either (sinistral) *eb* (or *esb*) and duplication of *ib* (or migration) of either *eb* or *esb* in the proximity of *ib*	–	2	–	2	50	50
UNILATERAL CHANGES						
Curvature of (sinistral) movable finger and reduction of (left) *et*	–	2	–	2	100	0
Curvature of (dextral) movable chelal finger and reduction of (dextral) *isb*	2	–	–	2	0	100
Reduction of *it*, *est*, and *eb* (or *esb*) and duplication of *isb* (or migration of either *esb* or *eb* in the proximity of *isb*	2	–	–	2	0	100
Reduction of *eb* (or *esb*) and duplication of *isb*, or migration of either *esb* or *eb* in the proximity of *ib*	–	–	2	2	0	100
Reduction of *it*	2	–	–	2	0	100
Reduction of *isb*	2	14	–	16	63	37
Reduction of *ib*	–	2	–	2	0	100
Migration of *isb* in the proximity of *ib*	–	2	–	2	0	100
Migration of *esb* in the proximity of *ib*	2	–	–	2	100	0
Migration of *esb* in the proximity of *ib*, and distal migration of *ist*	2	–	–	2	0	100
Migration of *eb* and *esb* in the proximity of *ib*	–	2	–	2	100	0
Migration of *eb*, *esb*, and *isb* in the proximity of *ib*	2	–	–	2	0	100
Duplication of *isb*	2	–	–	2	0	100
Duplication of *est*	2	–	–	2	100	0
Duplication of *eb* (or *esb*)	4	–	–	4	50	50
Reduction of *esb*	4	–	–	4	0	100
Reduction of *eb* (or *esb*)	2	10	2	14	86	14
Reduction of *eb* (or *esb*) and migration of *esb* or (*eb*) in the proximity of *ib*	–	4	–	4	0	100
Reduction of *eb* (or *esb*) and migration of *esb* (or *eb*) in the proximity of *isb*	–	4	–	4	50	50
Distal migration of *esb*	–	8	–	8	50	50
Reduction of *t* (or *st*)	4	2	–	6	33	67
Reduction of *t* and *st*	2	–	–	2	0	100
Duplication of *t* (or *st*)	2	–	–	2	0	100
Reduction of *st*	–	–	2	2	0	100
Reduclion of *b* (or *sb*)	–	2	–	2	100	0
Reduction of *sb*	2	–	–	2	0	100
Reduction of *b*	2	–	–	2	0	100
Total	40	54	6	100		
Mean					31	69



FIGS 1–12

Trichobothrial variation of chela in females of *Roncus pannonius* (1–11 abnormal, 12 normal): 1. right, *it*, *est*, and *eb* (or *esb*) missing, *isb* doubled (or migration of *esb* or *eb* towards *isb*); 2. right, *it* missing; 3. right, *isb* missing; 4. right, *isb* doubled; 5. left, *eb* (or *esb*) missing; 6. right, *eb* or *esb* doubled; 7. right, *t* or *st* missing; 8. left, *t* or *st* missing; 9, right, *t* or *st* missing; 10. right, *t* or *st* doubled; 11. right, *sb* missing; 12. left chela, normal trichobothrial pattern. Scale line = 0.5 mm.



Figs 13–21

Trichobothrial variation of chela in males (13–19) and tritonymphs (20, 21) of *Roncus pannonius*: 13. left, *et* missing; 14. left, *eb* or *esb* missing, migration of *esb* or *eb* towards *isb*; 15. left, *isb* missing; 17. right, *ib* missing; 18. left, *eb* or *esb* missing; 19. right, *t* or *st* missing; 20. right, *eb* (or *esb*) missing, *isb* doubled (or migration of *esb* or *eb* towards *ib*) (movable finger is normal); 21. right, *st* missing (fixed finger is normal). Scale line = 0.5 mm.

number (reduction or duplication); (2) changes, affecting both pedipalpal chelae, were noted in only 2% of specimens with an aberrant trichobothriotaxy; (3) the most frequent variants on the fixed chelal finger were: reduction of *isb* (16% of all trichobothrial changes), reduction of *eb* and *esb* (14%), and distal migration of esb (8%); (4) the most frequent variant on the movable chelal finger was the reduction of either *t* or *st* (6%). All other changes of trichobothriotaxy were less frequent (2–4% each; Figs 1–21, Table 1).

Unilateral changes are predominantly dextral, both on the fixed (68%) and movable chelal fingers (81%). Generally, such variations occur more frequently on the right than on the left (69% vs. 31%; Table 1). Additionally, the frequency of different trichobothrial changes, expressed as a percentage of the numbers of specimens examined for each stage revealed that 1.65% of females showed such changes, 1.69% of males and 0.47% of tritonymphs.

Both dextral and sinistral occurrence of trichobothrial changes ("asymmetry") was tested statistically (chi-square test) for all adult specimens of the species studied (other, preadult, stages were not analysed due to their small sample size). The results of this analysis revealed no significant differences between the occurrence of changed trichobothriotaxy on the left and right pedipalpal chelae (chi-square = 0.79; $P > 0.05$). However, when males and females were tested separately for asymmetry, a subsequent analysis clearly showed the sex difference in relation to the distribution of changed trichobothrial variants. It seems that only females exhibit significant presence of asymmetry in the trichobothrial pattern (more changes on the right) (chi-square = 5.00; $P < 0.05$), but not males (chi-square = 0.62; $P > 0.05$).

DISCUSSION

Until additional information (including larger samples size) become available, it is difficult to present a plausible interpretation of sexual differences in the distribution of changed trichobothrial patterns in the species studied. However, one of the possible explanations of the sexual dimorphism (in relation to asymmetry in trichobothrial variants) could be the presence of a more intensive selection (? sexual) against asymmetry of trichobothrial changes in males, and of a less intensive selection in females. This view is supported by the fact that the trichobothria-beset pedipalps play an important role, not only in capturing and manipulating prey and the small particles used for nest building, but also in fighting and making "social" contact in courtship and mating (WEYGOLDT 1969).

Apart from some physical, mechanical, and chemical factors (ĆURČIĆ 1980), it is probable that both developmental and genetic factors spark the origin of changes in the trichobothrial pattern of *R. pannonius*. Some of these factors influence the origin of such changes during late embryogenesis (viz. structural aberrations of pedipalpal chelal fingers and aberrations in the disposition of *et*, *eb*, *ist*, and *t*, which are first seen in the protonymph). Others are probably active during postembryogenesis or during each of the moulting periods (thus affecting the origin and position of *est*, *it*, *ib*, and *b*, which occur in the deutonymph; the origin of *esb* and *st*, which occur in the tritonymph; and the origin of *isb* and *sb*, which are first seen in the adult stage).

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